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IN THE UNITED STATES PATENT AND TRADEMARK OFFICE
BEFORE THE BOARD OF PATENT APPEALS AND INTERFERENCES

Applicants: Roger R. Lesieur
Serial No.: 09/321,390
Filed: May 27, 1999
For: "Compact Light Weight Autothermal Reformer Assembly"

Docket No.: C-2267
Group: 1764
Examiner: B. Ridley

APPEAL BRIEF UNDER RULE 192

Hon. Commissioner of Patents and Trademarks
Washington, D.C. 20231

Dear Sir:

This is an appeal brief appealing from the decision of the Examiner dated November 1 2000 finally rejecting claims 1-7 and 9-19, 21 and 22 in the above-identified application.

(1) REAL PARTIES IN INTEREST:
International Fuel Cells, LLC, South Windsor, CT

(2) RELATED APPEALS AND INTERFERENCES:
None.

(3) STATUS OF CLAIMS:
Claims 1-22 were originally submitted for examination. Claims 8 and 20 were canceled without prejudice. Claims 1, 3-7, 9, 10, 12-14, and 19-22 have been amended. Presently, Claim 19 stands rejected under 35 USC§103; Claims 1-6, 9-12 and 16-18 stand rejected under 35 USC §103; Claims 13-15 stand rejected under 35 USC§103; Claims 1, 7 and 21 stand rejected under 35 USC§103; and Claim 22 stands rejected under 35 USC§103. Claims 1-7, 9-18, 21 and 22 have been objected to. Claims 1-7, 9-18, 21 and 22 stand rejected under 35 USC §112, second paragraph. All other previous rejections of these claims have been withdrawn. No claims have been allowed or have been indicated as being allowable. The specification has been objected to due to the alleged uncertainty of the phrase "catalyzed cells" in the specification. The final rejections of claims 1-7 and 9-19, 21 and 22 are appealed herein.

(4) STATUS OF AMENDMENTS:
All amendments have been entered, or will be entered upon the filing of this appeal brief.

(5) SUMMARY OF THE INVENTION:

The invention relates to a hydrocarbon fuel gas autothermal reformer assembly (3) which includes a monolithic open cell foam catalyst bed (2). The catalyst bed includes an inlet end (8) and an outlet end (10), and an inlet portion of said catalyst bed is provided with a catalyst which is operable to combust a portion of the fuel gas so as to raise the temperature of the catalyst bed while inhibiting carbon deposition in catalyzed cells (6) of the foam. A fuel gas inlet passage (44) is included, and the fuel gas inlet passage is disposed in heat exchange relationship with a processed fuel gas stream disposed in an outlet passage (22) from the catalyst bed whereby heat will be transferred to the fuel gas inlet passage from the processed fuel gas stream (D). An air inlet passage (46) is disposed in heat exchange relationship with the processed fuel gas stream (D) whereby heat from the processed fuel gas stream will be transferred to said air inlet passage. A fuel gas reforming catalyst is deposited in the foam catalyst bed.

The catalyst bed preferably includes at least two catalyst regions which have different catalyst compositions. The regions include a first (inlet) region which may have a noble metal catalyst and the second (outlet) region has a base metal catalyst. Both regions, when two regions are present, preferably include calcium oxide. The first region may have an iron oxide/calcium oxide catalyst. A number of different foam compositions are possible. The foam, if made from a conductive material, can be electrically heated up to operating temperatures with a battery (5) during start up of the reformer assembly. Claims 21 and 22 require that the temperature in the inlet end of the catalyst bed be raised to a temperature of about 500ºF by combusting some of the fuel gas.

FIGS. 1 and 2 illustrate the aforesaid structure of the reformer and of the catalyst bed, and pages 6-11 of the specification describe the aforesaid structure and how to make the structure.

(6) ISSUES:

A. Does the use of the phrase "catalyzed cells" render the specification unclear?

B. Does the use of the phrase "the fuel gas" in Claims 1-7, 9-18, 21 and 22 have sufficient antecedence?

C. Does the use of the phrase "catalyzed cells" in Claims 1, 21 and 22 render these claims indefinite?

D. Does the inclusion of the phrase "the processed gas stream" in Claims 1 and 21 render these claims indefinite?

E. Is the subject matter of Claim 19 rendered obvious by the combined teachings of Clawson and Narumiya et al?

F. Is the subject matter of Claims 1-6, 9-12 and 16-18 rendered obvious by the combined teachings of Clawson, Narumiya et al and Setzer et al '484?

G. Is the subject matter of Claims 13-15 rendered obvious by the combined teachings of Clawson, Narumiya et al, Setzer et al '484 and Sheller?

H. Is the subject matter of Claims 1, 7 and 21 rendered obvious by the combined teachings of Clawson, Narumiya et al and Setzer et al '578?

I. Is the subject matter of Claim 22 rendered obvious by the combined teachings of Setzer et al '578 and Narumiya et al?

(7) GROUPING OF CLAIMS:
Claims 1-13 and 16-19 stand or fall together; Claims 14 and 15 stand or fall together; and Claims 21 and 22 stand or fall together. The patentability of each of the three sets of claims over the cited prior art will be argued separately.

(8) THE ARGUMENT:
The Rejections and Objections:
The use of the phrase "catalyzed cells" renders the specification unclear. The use of the phrase "the fuel gas" in Claims 1-7, 9-18, 21 and 22 does not have sufficient antecedence, and therefore renders the claims unclear. The use of the phrase "catalyzed cells" in Claims 1, 21 and 22 renders these claims indefinite. The inclusion of the phrase "the processed gas stream" in Claims 1 and 21 renders these claims indefinite. The subject matter of Claim 19 is rendered obvious by the combined teachings of Clawson and Narumiya et al. The subject matter of Claims 1-6, 9-12 and 16-18 is rendered obvious by the combined teachings of Clawson, Narumiya et al and Setzer et al '484. The subject matter of Claims 13-15 is rendered obvious by the combined teachings of Clawson, Narumiya et al, Setzer et al '484 and Sheller. The subject matter of Claims 1, 7 and 21 is rendered obvious by the combined teachings of Clawson, Narumiya et al and Setzer et al '578. The subject matter of Claim 22 is rendered obvious by the combined teachings of Setzer et al '578 and Narumiya et al.

The References Relied Upon:
U.S. Patent No. 4,308,233 Narumiya et al, granted 12-29-81;
U.S. Patent No. 4,415,484 Setzer et al, granted 11-15-83;
U.S. Patent No. 4,451,578 Setzer et al, granted 5-29-84;
U.S. Patent No. 5,384,099 Sheller, granted 1-24-95; and
WO 98/08771 Clawson, published 3-5-98.

A Brief Description Of The References:
The Narumiya et al reference discloses a device for purifying exhaust gas, such as a smelly gas, a carbon monoxide gas or the like which is produced by small sized

internal combustion equipment. The device 1 includes a ceramic porous body 3 which includes a plurality of interconnected voids 2 and cell strands 3a covered with activated alumina 4 which in turn is covered by a noble metal catalyst layer 5. The gas stream being purified by the device has its noxious components oxidized by the catalyst or the smelly components can be absorbed by the activated alumina coating on the cell strands. (See Col. 6, line 47 through Col. 7, line 3). Thus CO will be oxidized to CO_2 if a carbon monoxide laden gas stream is being purified; or if a smelly gas stream is being purified, the activated alumina layer is said to surely absorb smelly components in the gas stream. The catalyst in Narumiya et al is thus either an oxidizing catalyst or an absorbent catalyst, thus the Narumiya et al exhaust gas stream purifier uses either oxidization of gas stream components, or absorption of gas stream components.

The Setzer et al '484 reference describes a catalytic steam-fuel gas stream reformer which utilizes an alumina pellet catalyst bed. The alumina pellets are impregnated by calcia (calcium oxide). The calcia-impregnated alumina pellets are coated with a rhodium catalyst. The operating temperature of the reformer appears to be about 1,360°F (see Col. 4, line 10).

The Setzer et al '578 reference discloses a system for the catalytic steam reforming of a gaseous or liquid hydrocarbon fuel stream which utilizes the injection of steam into the hydrocarbon fuel stream. The system utilizes a catalyst substrate which may comprise lanthanum or ceria-impregnated alumina. The catalyst is an iron oxide which is deposited on the substrate. This system also seems to operate at a temperature of 1,360°F (see Col. 5, line 46).

The Sheller reference discloses a component of a catalytic converter core which is electrically heatable and which is coated with a catalyst that promotes oxidation of pollutants in an internal combustion engine or turbine exhaust stream. For example, carbon monoxide in the exhaust is oxidized to carbon dioxide. The pollutants are in essence burned in the converter. The reference also discloses a catalytic converter core which is made up of a plurality of the aforesaid components.

The Clawson reference discloses a hydrocarbon steam reformer for converting the hydrocarbon fuel to hydrogen and carbon dioxide. A mixture of fuel and steam enters a helical tube 32 along with air from an oxygen source 42. The air-steam-fuel mixture is fed into a partial oxidation zone 24 in the reformer where a portion of the fuel is burned to heat the reformer up. The zone 24 operates at a temperature of at least about 1,700°F (950°C) as noted on page 12 of the reference. A granular catalyst bed 28 forms a steam reforming zone 26 which is down stream from the zone 24. The air-steam-fuel mixture flows upwardly through the reforming zone 26 and then flows downwardly in heat exchange relationship with the helical tube 32. The reformed gas, or process gas, then passes through two shift converter beds 64 and 84 and then it

leaves the reformer assembly.

The Rejections and Objections:

"The disclosure is objected to because of the following informalities: - use of term "catalyzed cells" throughout the specification. It is not clear to the examiner what is meant by this term. Are cells of the catalyst bed being changed by a catalytic reaction (being catalyzed)? Is the catalyst used to catalyze cells of the catalyst bed in addition to catalyzing the reforming reaction of fuel gas?

Appropriate correction is required.

Claim Objections
Claims 1-7, 9-18 and 21 are objected to because of the following informalities: in claims 1 and 21, the term "an process fuel gas stream outlet passage" (line 8 of both claims) is objected to, suggested correction is --a process fuel gas stream outlet passage--.

Appropriate correction is required.

Claim Rejections - 35 USC § 112
The following is a quotation of the second paragraph of 35 U. S.C. 112: The specification shall conclude with one or more claims particularly pointing out and distinctly claiming the subject matter which the applicant regards as his invention,

Claims 1-7, 9-18 and 21-22 are rejected under 3 5 U. S. C. 112, second paragraph, as being indefinite for failing to particularly point out and distinctly claim the subject matter which applicant regards as the invention.

Claims 1 and 21-22 recite the limitation "the fuel gas" (line 4 of all aforementioned claims). There is insufficient antecedent basis for said limitation in the claim. Proposed correction is --a fuel gas--.

Claims 1 and 21-22 recite the limitation "catalyzed cells" (line 5 of claim I and line 6 of claims 21-22). It is not clear to the examiner what is meant by this limitation. Are cells of the catalyst bed being changed by a catalytic reaction (being catalyzed)? Is the catalyst used to catalyze cells of the catalyst bed in addition to catalyzing the reforming reaction of fuel gas?

Claims 1 and 21 recite the limitation "the processed gas stream' (lines 9-10 and 12 of claim I and in lines 9-10 of claim 21). There is insufficient antecedent basis for said limitation in the claim. Proposed correction: in lines 9-10 of both claims change "the processed gas stream" to --a processed gas stream-- and insert --the-- before "processed" in line 12 of claim 21.

Claim Rejections - 35 USC § 103

The following is a quotation of 35 U.S.C. 103(a) which forms the basis for all obviousness rejections set forth in this Office action: (a) A patent may not be obtained though the invention is not identically disclosed or described as set forth in section 102 of this title, if the differences between the subject matter sought to be patented and the prior art are such that the subject matter as a whole would have been obvious at the time the invention was made to a person having ordinary skill in the art to which said subject matter pertains. Patentability shall not be negatived by the manner in which the invention was made.

Claim 19, as best understood, is rejected under 35 U. S.C. 103(a) as being unpatentable over Clawson (WO 98/08771), in view of Narumiya et al. (USP 4,308,233). Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising: a) a catalyst bed (200) including an inlet end (2 1 0) and an outlet end (270); b) a fuel gas/steam mixture inlet passage (208, P2O/L7-9); c) a fuel gas reforming catalyst (225) deposited in said catalyst bed (200).

While Clawson does disclose using a supported catalyst in the catalyst bed, the reference does not disclose the catalyst being supported on a cylindrical monolithic open cell foam.

Narumiya et al. teaches a catalyst bed comprising: a cylindrical monolithic open cell foam structure (Fig. 1, C4/L30-32). It would have been obvious to one having ordinary skill in the art at the time the invention was made to use a monolithic open cell foam structure, as taught by Narumiya et al., as support for the catalyst in the assembly of Clawson, for the purpose of providing structure which allows the fuel gas to always be in contact with the surface of the catalyst to accelerate gas diffusion and to prevent the direct passage of unreacted gas.

Claims 1-6, 9-12 and 16-18, as best understood, are rejected under 35 U. S.C. 103(a) as being unpatentable over Clawson (WO 98/08771), in view of Narumiya et al. (USP 4,308,233), as set forth above, and further in view of Setzer et al. (USP 4,415,484).

Regarding claims 1 and 16, Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising: a) a catalyst bed (200) including an inlet end (210) and an outlet end (270); wherein an inlet portion of said catalyst bed is operable to combust a portion of the fuel gas (P24/L 1-7); b) a fuel gas inlet passage (208); wherein - said fuel gas inlet passage (208) being disposed in heat exchange relationship with an processed fuel gas stream outlet passage from said catalyst bed (P20/L9-11 & P21/L7- 10); c) an air inlet passage (232); and said air inlet passage (232) being disposed in heat exchange relationship with processed gas stream (P22/13-15); d) a fuel gas reforming catalyst (225) deposited in said catalyst bed (200).

While Clawson does disclose using a supported catalyst in the catalyst bed, the reference does not disclose the catalyst being supported on a cylindrical monolithic open cell foam.

With respect to Narumiya et al. the same comments apply as set forth above.

While Clawson does disclose combusting portion of the fuel gas in the inlet portion of the reactor, the reference does not disclose the catalyst bed being provided with a catalyst which is operable to combust a portion of the fuel gas.

Setzer et al. teaches an inlet portion of a catalyst bed being provided with: - a catalyst which is operable to combust a portion of the fuel gas (C4/L42-52).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a catalyst which is operable to combust a portion of the fuel gas, as taught by Setzer et al., in the inlet portion of the catalyst bed of Clawson, for the purpose of allowing greater flexibility in the maximum allowable reactor temperature and the method of introducing the air into the reactor.

Regarding claims 2-5, Clawson, in view of Narumiya et al. and further in view of Setzer et al. disclose all of the claim limitations as set forth above. Additionally Setzer et al. teaches an autothermal reformer assembly, wherein: said catalyst bed includes a noble metal and calcium oxide (C2/L5-6); said foam catalyst bed comprises at least two catalyzed regions (C4/L59-63); wherein each region has a different catalyst composition (C4/L59-63); a first region of said foam catalyst bed contains a noble metal catalyst in combination with calcium oxide (C3/L21-22 & C4/L53-55); a second region of said foam catalyst bed contains a base metal catalyst in combination with calcium oxide (C3/L20-21 & C4/L45-46).

Regarding claims 6 and 9, Clawson in view of Narumiya et al. and further in view of Setzer et al. disclose all of the claim limitations as set forth above, additionally, while the references do not explicitly disclose said first region containing platinum catalyst and said second region containing a nickel catalyst, both nickel and platinum catalysts were well known in the art at the time the invention was made (as evidenced by Clawson (P 19/L27-P20/L7)), the catalyst selection being driven by system requirements, such as desired catalyst activity, and by catalyst cost. As the instant specification is silent to unexpected results, it would have been obvious to one having ordinary skill in the art at the time the invention was made to use a platinum catalyst in said first region and a nickel catalyst in said second region of the catalyst bed, as disclosed by Clawson, in view of Narumiya et al. and further in view of Setzer et al., for the purpose of obtaining desired catalyst activity.

Regarding claims 10- 11, Clawson, in view of Narumiya et al. and further in view of Setzer et al. disclose all of the claim limitations as set forth above. Additionally Setzer

et al. teaches an autothermal reformer assembly, wherein: said catalyst bed includes a first region which contains a noble metal catalyst and calcium oxide catalyst (C4/L53-55); said noble metal catalyst is selected from the group consisting of platinum, palladium, rhodium and mixtures thereof (C4/L53-55).
While Clawson, in view of Narumiya et al. and further in view of Setzer et al. do not explicitly disclose said second region containing noble metal catalyst and not containing calcium oxide, noble metal catalyst not containing calcium oxide were well known in the art at the time the invention was made (as evidenced by Clawson (P19/L27-P20/L7)), the catalyst selection being driven by system requirements, such as desired catalyst activity, and by catalyst cost. As the specification is silent to unexpected results, it would have been obvious to one having ordinary skill in the art at the time the invention was made to use a noble metal catalyst not containing calcium oxide, as disclosed by Clawson, in view of Narumiya et al. and further in view of Setzer et al., for the purpose of obtaining desired catalyst activity.

Regarding claim 12, Clawson, in view of Narumiya et al. and further in view of Setzer et al. disclose all of the claim limitations as set forth above. Additionally Narumiya et al. teaches an assembly, wherein: said foam catalyst bed includes at least one ceramic foam support body (C2/L45-49).

Regarding claims 17-18, Clawson, in view of Narumiya et al. and further in view of Setzer et al. disclose all of the claim limitations as set forth above. Additionally Clawson discloses an autothermal reformer assembly, wherein: said fuel gas inlet passage contains a fuel gas/steam mixture (P23/L8-14); said air inlet passage contains air (P23/L19-22).

While Clawson, in view of Narumiya et al. and further in view of Setzer et al. do not explicitly disclose said air inlet passage containing an air/steam mixture, the usage of steam as a temperature modifier and to avoid soot formation in partial oxidation of hydrocarbons was well known in the art at the time the invention was made (as evidenced by Bhattacharyya et al. (USP 5,498,370)). As the specification is silent to unexpected results, it would have been obvious to one having ordinary skill in the art at the time the invention was made to add steam to the said air inlet passage, as disclosed by Clawson, in view of Narumiya et al. and further in view of Setzer et al., for the purpose of using the steam as a temperature modifier and to avoid soot formation.
8. Claims 13-15, as best understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over Clawson (WO 98/08771), in view of Narumiya et al. (USP 4,308,233), further in view of Setzer et al. (USP 4,415,484), as set forth above, and further in view of Sheller. (USP 5,384,099).

Clawson, in view of Narumiya et al. and further in view of Setzer et al. disclose all of the claim limitations as set forth above, but the references do not disclose the catalyst bed comprising a metal support selected from the group consisting of stainless steel, nickel alloys and iron-aluminum alloys, connected to a source of electrical current so

as to serve as a resistance heating element by being heated to operating temperature within about twenty seconds of applying electrical current thereto.

Sheller teaches a monolithic catalyst bed, wherein: said catalyst bed includes a metal support selected from the group consisting of stainless steel, nickel alloys and iron-aluminum alloys (C1/L26-29); said metal support is connected to a source of electrical current, so as to serve as a resistance heating element (C1/L52-63); said metal support is electrically heated to operating temperature within about twenty seconds of applying electrical current thereto (C1/L65-66).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a metal support connected to a source of electrical current, as taught by Sheller, in the catalyst bed of Clawson, in view of Narumiya et al. and further in view of Setzer et al., for the purpose of activating the catalyst during the start up of the reformer.

Claims 1, 7 and 21, as best understood, are rejected under 35 U.S.C. 103(a) as being unpatentable over Clawson (WO 98/08771), in view of Narumiya et al. (USP 4,308,233), as set forth above, and further in view of Setzer et al. (USP 4,451,578).

Regarding claim 1, Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising: a) a catalyst bed (200) including an inlet end (210) and an outlet end (270); wherein an inlet portion of said catalyst bed is operable to combust a portion of the fuel gas (P24/L1-7); b) a fuel gas inlet passage (208); wherein said fuel gas inlet passage (208) being disposed in heat exchange relationship with an processed fuel gas stream outlet passage from said catalyst bed (P20/L9-11 & P21/L7-10); c) an air inlet passage (232); and said air inlet passage (232) being disposed in heat exchange relationship with processed gas stream (P22/13-15); d) a fuel gas reforming catalyst (225) deposited in said catalyst bed (200).

While Clawson does disclose using a supported catalyst in the catalyst bed, the reference does not disclose the catalyst being supported on a monolithic open cell foam.

With respect to Narumiya et al. the same comments apply as set forth above.

While Clawson does disclose combusting portion of the fuel gas in the inlet portion of the reactor, the reference does not disclose the catalyst bed being provided with a catalyst which is operable to combust a portion of the fuel gas.

Setzer et al. teaches an inlet portion of a catalyst bed being provided with: - a catalyst which is operable to combust a portion of the fuel gas (C5/L53-59).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a catalyst which is operable to combust a portion of the fuel gas, as taught by Setzer et al., in the inlet portion of the catalyst bed of Clawson, for the purpose of allowing greater flexibility in the maximum allowable reactor temperature and the method of introducing the air into the reactor.

Regarding claim 7, Clawson, in view of Narumiya et al. and further in view of Setzer et al. disclose the claimed invention as set forth above. Additionally Setzer et al. teaches an autothermal reformer assembly, wherein: said first region contains an iron oxide/calcium oxide catalyst, and said second region contains nickel catalyst (C5/L53-61).

Regarding claim 21, Clawson discloses a similar autothermal reformer assembly (Fig. 3), the assembly comprising: a) a catalyst bed (200) including an inlet end (210) and an outlet end (270); wherein an inlet portion of said catalyst bed is operable to combust a portion of the fuel gas (P24/L 1 -7); b) a fuel gas inlet passage (208); wherein - said fuel gas inlet passage (208) being disposed in heat exchange relationship with an processed fuel gas stream outlet passage from said catalyst bed (P20/L9-1 I & P2 1/L7- I 0); c) an air inlet passage (232); and said air inlet passage (232) being disposed in heat exchange relationship with processed gas stream (P22/13-15); d) a fuel gas reforming catalyst (225) deposited in said catalyst bed (200).

While Clawson does disclose using a supported catalyst in the catalyst bed, the reference does not disclose the catalyst being supported on a monolithic open cell foam.

With respect to Narumiya et al. the same comments apply as set forth above.

While Clawson does disclose combusting portion of the fuel gas in the inlet portion of the reactor, the reference does not disclose the catalyst bed being provided with a catalyst which is operable to combust a portion of the fuel gas.

Setzer et al. teaches an inlet portion of a catalyst bed being provided with: a catalyst which is operable to combust a portion of the fuel gas (C5/L53-59); said catalyst bed being provided with promoted catalyst (C2/L29-30).

It would have been obvious to one having ordinary skill in the art at the time the invention was made to provide a catalyst which is operable to combust a portion of the fuel gas, as taught by Setzer et al., in the inlet portion of the catalyst bed of Clawson, for the purpose of allowing greater flexibility in the maximum allowable reactor temperature and the method of introducing the air into the reactor.

While Setzer et al. does disclose the catalyst bed being provided with promoted catalyst, the reference does not explicitly disclose the bed being promoted with a

noble metal catalyst which is operable to combust a portion of the fuel gas at a temperature of about 500ºF.

As promoters containing noble metal, were well known in the art at the time the invention was made (as evidenced by Peters (USP 5,110,780)), and as the specification is silent to unexpected results, it would have been obvious to one having ordinary skill in the art at the time the invention was made to use a noble metal-promoted catalyst which is operable to combust a portion of the fuel gas at a temperature of about 500ºF in said catalyst bed, as disclosed by Setzer et al., in view of Narumiya et al. for the purpose of increasing catalyst activity and lowering operation temperature.

Claim 22, as best understood, are (is) rejected under 35 U.S.C. 103(a) as being unpatentable over Setzer et al. (USP 4,451,578), in view of Narumiya et al. (USP 4,308,233).

Setzer et al. discloses a similar autothermal reformer assembly comprising: a catalyst bed (C5/L41); said catalyst bed including an inlet portion of said catalyst bed being provided with promoted catalyst (C2/L29-30), which is operable to combust a portion of the fuel gas (C5/L54-59);

While Setzer et al. does disclose using a supported catalyst in the catalyst bed, the reference does not disclose the catalyst being supported on a monolithic open cell foam.

With reference to Narumiya et al. the same comments apply as set forth above.

While Setzer et al. does not explicitly disclose the catalyst bed having an inlet end and an outlet end, these elements are inherent in the disclosed assembly.

While Setzer et al. does disclose the catalyst bed being provided with promoted catalyst, the reference does not explicitly disclose the bed being promoted with a noble metal catalyst which is operable to combust a portion of the fuel gas at a temperature of about 500ºF.

As promoters containing noble metal, were well known in the art at the time the invention was made (as evidenced by Peters (USP 5,110,780)), and as the specification is silent to unexpected results, it would have been obvious to one having ordinary skill in the art at the time the invention was made to use a noble metal-promoted catalyst which is operable to combust a portion of the fuel gas at a temperature of about 500ºF in said catalyst bed, as disclosed by Setzer et al., in view of Narumiya et al. for the purpose of increasing catalyst activity and lowering operation temperature.". The aforesaid objections and rejections are contained on pages 2-12

in Paper # 6.

The §112 Rejections and Objections

To begin with, the Examiner has based her objection to the specification and her §112 rejection of Claims 1, 21 and 22 on her allegation that the meaning of the phrase "catalyzed cells" is not clear to her. In our response to the final rejection, we have pointed out to the Examiner that §112 refers to what one skilled in the art would glean from the claimed subject matter and from the disclosure accompanying the claimed subject matter, and not what a Patent Examiner understands the disclosure and claimed subject matter to mean. The Examiner has responded to this point by alleging that she qualifies as one skilled in the art of hydrocarbon fuel reforming (which is the art in question in this case).

We quote her response to this point: "In response the examiner notes that she can be considered one of ordinary skill in the art, as the art area applicable in the instant invention is that of hydrocarbon reforming, and one of ordinary skill in this art is considered to have at least a BS degree, with additional education in the field and at least 3 years practical experience working in the art; is aware of the state of the art as shown by the references of record, to include those cited by applicants and the examiner (ESSO Research & Engineering v. Kahn & Co., 193 USPQ 582 [1974]) and who is presumed to know something about the art apart from what references alone teach (In re Bode, 193 USPQ 12, (16) [CCPA 1977]); and who is motivated by economics to depart from the prior art to reduce costs.".

There is nothing in the record in this case that indicates that Examiner Ridley has "at least a BS degree"; if she does, there is nothing in the record to indicate what technology her BS degree is in; there is nothing in the record that indicates that Examiner Ridley has at least "3 years of practical experience" in the field of hydrocarbon fuel reforming; and there is nothing in the record of this case to prove that Examiner Ridley knows anything at all about how to "reduce costs" in the field of hydrocarbon fuel reforming. Should Examiner Ridley further pursue these objection/rejections, then she must be required to prove the truthfulness of the aforesaid allegations relating to her position that she can be considered to be one of skill in the art of hydrocarbon fuel reforming. We submit that such proof would require a declaration or an affidavit by Examiner Ridley which will be made a part of the record as to facts which support her allegation that she is indeed one of skill in the aforesaid art.

We submit that the objection to Claims 1-7, 9-18 and 21 which is based on the inclusion of the phrase "an process" in these claims has been rendered moot by the amendment after final rejection, which the Examiner has indicated will be entered upon filing of this appeal brief.

We submit that the §112 rejection of Claims 1, 21 and 22 relating to an alleged lack of antecedence of the phrase "fuel gas" in line 4 of each of the claims is clearly erroneous. The phrase "fuel gas" is contained in line 1 of each of the aforesaid claims. This rejection should thus be reversed.

We submit that the §112 rejection of Claims 1, 21 and 22 based on the Examiner's allegation that the meaning of the phrase "catalyzed cells" is unclear to her has been rendered moot by the amendment to the specification which will be entered upon the filing of this brief. This rejection should therefore be withdrawn.

The rejection of Claims 1 and 21 based on the allegation that the phrase "the processed gas stream" has been rendered moot by the amendment of these claims to recite "processed fuel gas stream". This rejection should thus be withdrawn.

The §103 Rejections

Claim 19:

Claim 19 stands rejected as being obvious over the combination of Clawson and Narumiya et al. Clawson discloses a catalytic steam reformer and Narumiya et al discloses a catalytic converter for purifying burner exhaust gases. The Clawson reference uses a noble metal and/or nickel catalyst which is supported on a refractory carrier, the physical nature of which is not explained, except that it must be supported and confined by perforate screens. The Narumiya et al reference describes a ceramic foam support which has an activated alumina coating on it wherein the alumina coating is covered by a noble metal oxidizing catalyst. The smelly components and the CO in the burner exhaust being purified are oxidized, or burned, in the catalyst bed. The motivation put forth by the Examiner for substituting the Narumiya et al catalyst bed for the Clawson catalyst bed is to provide a catalyst bed which allows the fuel gas to always be in contact with the surface of the catalyst, to accelerate gas diffusion, and to prevent the direct passage of unreacted gas. It would appear that none of these problems exist in the Clawson reformer, and thus there is no motivation to substitute the Narumiya et al catalyst bed for the Clawson catalyst bed. Furthermore, one would not be likely to use an oxidizing catalyst bed in a steam reformer for a hydrocarbon fuel gas. If one did make such a substitution, the result would be to oxidize or burn all of the hydrocarbons in the fuel gas, which would be an undesirable in a steam reformer.

This argument was proffered during prosecution of this application, and the Examiner's response thereto is quoted now: "In response to applicant's argument that there is no suggestion to combine the references, the examiner recognizes that obviousness can only be established by combining or modifying the teachings of the prior art to produce the claimed invention where there is some teaching, suggestion, or motivation to do so found either in the references themselves or in the knowledge

generally available to one of ordinary skill in the art. See In re Fine, 837 F2d 1071, 5 USPQ2d 1596 (Fed. Cir. 1988) and In re Jones, 958 F2d 347, 21 USPQ2d 1941 (Fed. Cir. 1992). In this case, Narumiya et al., in C2/L24-31, states that (the) disclosed catalyst structure allows the fuel gas to always be in contact with the surface of the catalyst to accelerate gas diffusion and to prevent the direct passage of unreacted gas. Since this structure improves conversion, it will enhance performance of any catalytic device.

Further, the examiner notes that Narumiya et al. was not relied upon to teach using an oxidizing catalyst in a steam reformer. The examiner has however relied on the disclosure of Narumiya et al. to teach a cylindrical monolithic open cell foam structure (Fig. 1, C4/L30-32)."

The Examiner's allegation that a catalyst structure of the type shown in Narumiya et al "will enhance performance of any catalytic device" (emphasis added) is mere examiner speculation and is not supported by the evidence. Furthermore, the Examiners reliance on only a part of Narumiya et al, while ignoring the remainder of the reference, is improper. The Examiner must consider the reference as a whole, and she cannot pick and choose parts of the teachings of a reference which suit her position and ignore the rest. It is impermissible within the framework of section 103 to pick and choose from any one reference only so much of it as will support a given position, to the exclusion of other parts necessary to the full appreciation of what such reference fairly suggests to one of ordinary skill in the art. See: In re Umbricht, 160 USPQ 15 (CCPA 1968). See also In re Wesslau, 147 USPQ 391 (CCPA).

The rejection of Claim 19 is thus clearly erroneous and should be reversed.

This point about picking and choosing only so much of Narumiya et al as suits her purposes pervades this final rejection, since Narumiya et al is included in each of the rejections.

Claims 1-6, 9-12 and 16-18:

Claims 1-6, 9-12 and 16-18 stand rejected as being obvious over the combination of Clawson and Nuramiya et al in view of Setzer et al '484. The Examiner's characterization of details of the Clawson structure is incorrect. The fuel gas inlet line in Clawson is denoted by the numeral 219, not 208. The numeral 208 denotes the initial portion of the catalyst bed and is filled with a catalyst 214. The fuel comes from a source 217, passes through the line 219 and enters the initial portion 208 of the catalyst bed. Oxygen (air) enters the reformer 200 through a line 235 from an oxygen source 242. The air passes through a helical tube 232 which is disposed in an annular chamber which doesn't seem to numbered. The partially reformed gas stream passes through the annular chamber and then passes into a second catalyst bed 262. Thus, the air stream in the helical tube 232 is disposed in heat exchange relationship

with the partially reformed gas stream, but the fuel gas inlet passage 219 is not disposed in heat exchange relationship with the partially reformed gas stream. Thus, preheating of the fuel gas stream, as claimed in this application, does not occur in Clawson.

We agreed that Setzer et al '484 describes an autothermal reformer with a two stage catalyst bed. We did not agree that Setzer et al '484 describes a foam core catalyst bed as implied on page 11 of the office action dated June 2, 2000. Setzer et al clearly describes a pelletized catalyst bed. The Examiner's response to Applicant's disputing the Examiner's allegation that Setzer et al '484 teaches the use of a foam core catalyst is as follows: "The applicant argues that Setzer et al '484 does not teach a foam core catalyst. In response the examiner notes that Setzer et al. '484 was not relied upon to teach (a) foam catalyst regardless (of the) typographical error which included (the) phrase "foam core" in (the) rejection on page 11.".

This is the second "typographical error" contained in the office action dated 6-2-2000, the other relating to a recitation by the Examiner of "catalyzed calls", rather than "catalyzed cells".

Applicants have submitted conscientious arguments against the merits of these misspelled rejections, which arguments have been deflected by the Examiner, by what amounts to an allegation that the PTO support staff can't spell, and that we practioners should know that. We submit that Examiner Ridley should carefully review the spelling in an office action and review sentence structure, to make sure that her position is accurately and grammatically correctly set forth.

The Examiner's allegation that the catalyst tube 208 is disposed in heat exchange relationship with the processed fuel gas stream outlet passage, which is disposed between tubes 224 and 252, is clearly erroneous. The Honorable Board's attention is respectfully directed to FIG. 3 which is the figure upon which the Examiner is relying to support her allegation regarding heat exchange between the two recited gas streams.

We note that the Narumiya et al reference is being once again selectively dissected in putting forth the grounds for this rejection in the final rejection dated November 1, 2000. This is improper, as noted above, and is clearly erroneous.

In formulating the grounds for the rejections of the aforesaid claims, the Examiner has offered speculative motivation for modifying the subject matter of Clawson with the teachings of Narumiya et al and Setzer et al '484. Obviousness cannot be established by modifying the teachings of the prior art to produce the claimed invention, absent some teaching or suggestion supporting the modification. Under 35 USC 103, teachings of references can be combined only if there some suggestion or incentive to do so. **The motivation to combine or modify must be found in the prior art.** See: In re Gordon, 221 USPQ 1125 (Fed. Cir. 1988); In re Fine, 5 USPQ2d 1596 (Fed.

Cir. 1988); and In re Fritch, 23 USPQ2d 1780 (Fed. Cir. 1992). The Examiner has failed completely to point to anything in the three references that supports her position that the combination would allow "greater flexibility in the maximum allowable reactor temperature and the method of introducing the air into the reactor.". (see page 5, office action). Where does this alleged motivation come from?

The Examiner has made several allusions to the apparent need for "unexpected results" when determining what is patentable and unobvious. There is no requirement for unusual, unexpected or surprising results in Title 35 of the patent statute. Kansas Jack, Inc. v Kuhn et al 219 USPQ 857 (CAFC 1983). This allusion is therefore irrelevant to the question of patentability of any of the claims in this claim set.

It is therefore submitted that the rejection of these claims should be reversed.

Claims 13-15:

Claims 13-15 have been rejected as being obvious over the combined teachings of Clawson in view of Narumiya et al and further in view of Setzer '484 and still further in view of Sheller. It is noted that Sheller relates to a catalytic converter for burning pollutants in an internal combustion engine exhaust stream. The Examiner has alleged that the catalyst bed in Sheller is a monolith, quoting the Examiner: "Further, the examiner notes that Sheller, in C1/L53-C2/L16 in fact does teach a monolithic catalyst bed, wherein: said catalyst bed includes a metal support selected from the group consisting of stainless steel, nickel alloys and iron-aluminum alloys (C I /L26-29); said metal support is connected to a source of electrical current, so as to serve as a resistance heating element (C1/L52-63); said metal support is electrically heated to operating temperature within about twenty seconds of applying electrical current thereto (C1/L65-66).". Sheller itself belies this allegation in the very sections cited by the Examiner. The text in Col. 1, lines 53+ of Sheller discusses prior art monolith catalyst beds, and the Examiner goes on to state that these devices when electrically heated prove unsatisfactory (Col. 2 lines 50+). Sheller suggests that a catalyst bed must be formed from a plurality of corrugated metal strips 10 on which the catalyst is deposited in order to be electrically heatable. Sheller suggests that if the catalyst bed were formed from a monolith then it could not be satisfactorily electrically heatable due to the low electrical resistance of a monolithic catalyst bed (see Col. 2, lines 50-66). Thus the combination of the teachings of the four references as strung together by the Examiner would suggest that if one wanted to electrically heat a catalyst bed which is formed from an electrically conductive core, then the core could not be a monolithic core.

We note that the Narumiya et al reference is being once again selectively dissected in putting forth the grounds for this rejection in the final rejection dated November 1, 2000. This is improper, as noted above, and is clearly erroneous.

Claims 1, 7, 21 and 22:

Claims 1, 7 and 21 have been rejected as being obvious over the combined teachings of Clawson in view of Narumiya et al and further in view of Setzer et al '578. Claim 22 hs been rejected as being obvious over the teachings of Setzer et al '578 in view of Narumiya et al.

Regarding Claims 1, 7, 21 and 22, we note that the Narumiya et al reference is being once again selectively dissected in putting forth the grounds for this rejection in the final rejection dated November 1, 2000. This is improper, as noted above, and is clearly erroneous. For this reason alone, this rejection should be reversed.

Regarding Claim 7, this claim requires the presence of an iron oxide/calcium oxide catalyst mixture in the first region of the foam catalyst bed, and a nickel catalyst in the second region of the foam catalyst bed. On page 10 of the final rejection, the Examiner, in analyzing Setzer et al '578, states that Setzer et al '578, in Col. 5, lines 53-61 teaches an autothermal reformer wherein a first region of a catalyst bed contains an iron oxide/calcium oxide catalyst mixture and a second region containing a nickel catalyst. This allegation is clearly erroneous. Note that the subject matter of Claim 7 requires a supported catalyst, i.e., an iron oxide/calcium oxide catalyst mixture which is supported on the foam monolith. The quoted portion of Setzer et al '578 clearly indicates that the inlet portion of the catalyst bed include only an iron oxide catalyst, and does not suggest an iron oxide/calcium oxide catalyst mixture. This mixture of catalysts is what inhibits carbon deposition in the catalyzed cells of the first region of the foam. The rejection of Claim 7 is thus clearly erroneous and should be reversed.

Regarding Claims 21 and 22, these claims require the achievement of a reformer assembly start up temperature of about 500°F which will enable start up of the reformer while inhibiting carbon deposition in catalyzed cells in the foam catalyst bed. A phrase in these claims that the Examiner has repeatedly attacked is the phrase: "operable to". The Examiner seems to think that this phrase, and limitations that follow this phrase, can be ignored when determining the patentability of a claim that contains this phrase.

The Federal Circuit (CAFC) and its predecessor patent court, the Court of Customs and Patent Appeals (CCPA) have repeatedly stated that the claimed subject matter (or the claimed invention) as a whole must be considered when analyzing questions of patentability or infringement. This is a cardinal rule in patentability examination.

Applicants have pointed this error out to the Examiner in prior responses, and the sums the Examiner's position regarding the patentability of Claim 21: "The applicant argues that combination of references used to reject claims 21-22 does not disclose a reformer assembly which combusts a portion of the fuel gas at a temperature of about

500oF to enable start-up of the reformer assembly.

In response the examiner notes that said reference combination was not relied upon to disclose a reformer assembly which combusts a portion of the fuel gas at a temperature of about 500°F. The examiner has however relied on said reference combination to disclose a reformer assembly which is operable to combusts (combust) a portion of the fuel gas at a temperature of about 500°F, as the term operable means "being such that use or operation is possible" (The American Heritage Dictionary of the English Language, Third Edition copyright 1992 by Houghton Mifflin Company; Electronic version licensed from INSO Corporation). As combustion of a portion of the fuel gas stream at a temperature of about 500°F does not impart any further structural limitations on the reformer assemblage as disclosed by said combination of references, it is examiner's position that said reformer assemblage is operable to combusts (combust) a portion of the fuel gas at a temperature of about 500°F.".

The Federal Circuit (CAFC) and its predecessor patent court, the Court of Customs and Patent Appeals (CCPA) have repeatedly stated that the claimed subject matter (or the claimed invention) as a whole must be considered when analyzing questions of patentability or infringement.

In the instant case, the three reformer patents cited by the Examiner require a reforming temperature of from 1,360°F (the Setzer references) to about 1,700°F (Clawson). There is absolutely no suggestion in the three reformer patents that they would be capable of, or able to, or operable to, or even possibly could, operate at reforming temperatures of about 500°F. The Examiner has dismissed this fact by stating that the operating temperature recited in Claims 21 and 22 are not structural limitations and thus can be ignored, in essence, when determining patentability of these claims. This position flies in the face of the cardinal rule of "subject matter as a whole", noted above. This position is thus clearly erroneous, and must be reversed.

Non-analogous arts:
We submit that Narumiya et al and Sheller are directed to arts which are non-analgous arts, as that concept in used in connection with patent law. The inquiry as to whether disparate arts are "analogous arts" must be clearly focused in order to conform to MPEP guidelines and case law. The Honorable Board's attention is directed to §2141.01(a) of the MPEP for guidance in this area of the law. The MPEP directs our attention to the "problem" an inventor is attempting to solve, when considering whether one teaching relates to an art that is analogous to a teaching in a disparate art. The test for analogous arts, and has characterized the test as being: "a prior art reference +++ must be reasonably pertinent to the particular problem with which the applicant was concerned, in order to be relied upon as a basis for the claimed invention." (page 4 of paper number 9). In the instant case, three prior art references, Clawson and the two Setzer references, are concerned with hydrocarbon fuel gas reforming, as is the

applicant here, while the Narumiya et al reference and the Sheller reference are concerned with the conversion of noxious compounds in an exhaust gas stream to innoxious compounds by burning the noxious compounds in a catalytic converter., Applicant is concerned with the catalytic reforming of a hydrocarbon fuel gas. The problem of reforming a hydrocarbon fuel gas relates to minimal burning of components of the fuel gas so as to preserve the hydrogen content, and the problem of detoxifying an exhaust gas stream relates to maximized burning of the components of the gas stream. These are not analogous problems. The two catalytic converter references cited by the Examiner do not suggest the commonality of the two disparate problems in the systems described in the references.

The Honorable Board is thus respectfully requested to recognize the fact that the art of reforming a hydrocarbon fuel gas and the art of detoxifying an exhaust gas are disparate and non-analogous arts under the guidelines established by the USPTO.

SUMMARY

For the reasons advanced above, the Honorable Board is respectfully requested to reverse the final rejections of Claims 1-7, 9-19 and 21-22, or any individual ones of these claims.

Respectfully submitted,

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(9) APPENDIX:

1. A hydrocarbon fuel gas autothermal reformer assembly comprising:
a) a monolithic open cell foam catalyst bed, said catalyst bed including an inlet end and an outlet end, an inlet portion of said catalyst bed being provided with a catalyst which is operable to combust a portion of the fuel gas so as to raise the temperature of said catalyst bed while inhibiting carbon deposition in catalyzed cells of said foam;
b) a fuel gas inlet passage, said fuel gas inlet passage being disposed in heat exchange relationship with a processed fuel gas stream disposed in an outlet passage from said catalyst bed whereby heat will be transferred to said fuel gas inlet passage from the processed fuel gas stream;
c) an air inlet passage, said air inlet passage being disposed in heat exchange relationship with the processed fuel gas stream whereby heat from the processed fuel gas stream will be transferred to said air inlet passage; and
d) a fuel gas reforming catalyst deposited in said foam catalyst bed.

2. The autothermal reformer assembly of Claim 1 wherein said catalyst bed includes a noble metal and calcium oxide.

3. The autothermal reformer assembly of Claim 1 wherein said foam catalyst bed comprises at least two catalyzed regions wherein each region has a different catalyst composition.

4. The autothermal reformer assembly of Claim 3 wherein a first region of said foam catalyst bed contains a noble metal catalyst in combination with calcium oxide.

5. The autothermal reformer assembly of Claim 4 wherein a second region of said foam catalyst bed contains a base metal catalyst in combination with calcium oxide.

6. The autothermal reformer assembly of Claim 5 wherein said first region of said foam catalyst bed contains a platinum catalyst, and said second region of said foam catalyst bed contains a nickel catalyst.

7. The autothermal reformer assembly of Claim 4 wherein said first region of said foam catalyst bed contains an iron oxide/calcium oxide catalyst mixture and said second region of said foam catalyst bed contains a nickel catalyst.

9. The autothermal reformer assembly of Claim 4 wherein said noble metal catalyst is a catalyst selected from the group consisting of platinum, palladium and rhodium, and mixtures thereof.

10. The autothermal reformer assembly of Claim 1 wherein said foam catalyst bed includes a first region which contains a noble metal catalyst and a calcium oxide catalyst, and a subsequent region which does not contain calcium oxide and does contain said noble metal catalyst.

11. The autothermal reformer assembly of Claim 10 wherein said noble metal catalyst is selected from the group consisting of platinum, palladium and rhodium.

12. The autothermal reformer assembly of Claim 1 wherein said foam catalyst bed includes at least one ceramic foam support body.

13. The autothermal reformer assembly of Claim 1 wherein said foam catalyst bed includes a metal support selected from the group consisting of stainless steel, nickel alloys and iron-aluminum alloys.

14. The autothermal reformer assembly of Claim 13 wherein said metal support is connected to a source of electrical current so as to serve as a resistance heating element during start-up of said reformer assembly.

15. The autothermal reformer assembly of Claim 14 wherein said metal support is electrically heated to operating temperatures within about twenty seconds after applying electrical current thereto.

16. The autothermal reformer assembly of Claim 1 wherein said catalyst bed is cylindrical in shape.

17. The autothermal reformer assembly of Claim 1 wherein said fuel gas inlet passage contains a fuel gas/steam mixture.

18. The autothermal reformer assembly of Claim 1 wherein said air inlet passage contains an air/steam mixture.

19. A hydrocarbon fuel gas autothermal reformer assembly comprising:
a) a cylindrical monolithic open cell foam catalyst bed, said catalyst bed including an inlet end and an outlet end;
b) a fuel gas/steam mixture inlet passage; and
c) a fuel gas reforming catalyst deposited in said cylindrical foam catalyst bed.

21. A hydrocarbon fuel gas autothermal reformer assembly comprising:
a) a monolithic open cell foam catalyst bed, said catalyst bed including an inlet end and an outlet end, an inlet portion of said catalyst bed being provided with a noble metal-promoted catalyst which is operable to combust a portion of the fuel gas at a temperature of about 500°F thereby enabling start up of the reformer assembly while inhibiting carbon deposition in catalyzed cells of said foam;
b) a fuel gas inlet passage, said fuel gas inlet passage being disposed in heat exchange relationship with a processed fuel gas stream disposed in an outlet passage from said catalyst bed whereby heat will be transferred to said fuel gas inlet passage from the processed gas stream;

c) an air inlet passage, said air inlet passage being disposed in heat exchange relationship with processed fuel gas stream whereby heat from the processed fuel gas stream will be transferred to said air inlet passage; and
d) a fuel gas reforming catalyst deposited in said foam catalyst bed.

22. A hydrocarbon fuel gas autothermal reformer assembly comprising a monolithic open cell foam catalyst bed, said catalyst bed including an inlet end and an outlet end, an inlet portion of said catalyst bed being provided with a noble metal-promoted catalyst which is operable to combust a portion of the fuel gas at a temperature of about 500°F thereby enabling start up of the reformer assembly while inhibiting carbon deposition in catalyzed cells of said foam catalyst bed.